limit, $l\,dx$ = the element of area described. In passing over a finite area this will equal $\int l\,dx = lx$, where x is the whole distance recorded by the roller. If now the roller be mounted at a distance r from the centre of the line, in traversing the element of area as before, it will first record $l\,dx$ in its motion parallel to itself, and then, as the line turns about its centre, it will either add or subtract from that reading an amount corresponding to the arc of the circle of radius r, through which it turns; the roller will thus show $l\,dx \pm r\,d\theta$, where $d\theta$ is the small angle turned through. In traversing a finite area this will record $lx \pm r\theta$ where θ is the angle between the initial and final positions of the line. It is now obvious that if the initial and final positions of the line are parallel or coincident, the area passed over by the line will be equal to the area recorded by the roller, even though it were not mounted on the centre of the line, as the second term in the expression just given vanishes. Returning now to the illustration, we see the line represented by the rod carrying the roller, its two extremities being the tracer and the axis of the pivot. Assume that the tracer is placed at the extreme right of the area to be measured: by moving it to the extreme left the roller is made to record an area differing by $\pm r\theta$ from the whole area between the initial and final positions of the rod, and bounded by the portion of the circle described by the further extremity of the rod and by that portion of the boundary of the area traversed, r and θ having the meanings previously assigned to them. Let the tracer be now carried round the boundary back to its starting point on the other side of the area; the roller will now revolve the reverse way, and will subtract from its previous reading an area differing by $\mp r\theta$ from the area contained between the two positions of the rod, the arc described by the pivot and the portion of boundary traversed. It is now apparent that the reading of the roller gives the difference of these areas, which is that of the figure required (Fig. 4).[1] A different form of the polar planimeter is shown in the second illustration, and is provided with an adjustment for varying the effective length of the arm carrying the tracer, by which means the dial and the graduations on the roller are made to show the area to different scales. Mr. F. J. Bramwell was, we believe, the first to publish an intelligible description of the planimeter. This the author refers to, but has rendered it incomplete and far from lucid by condensing it; we would, however, refer him to a short account of the instrument published by Mr. F. P. Purvis in the *Philosophical Magazine* for July, 1874.

With this sketch of two of the most important instruments described by Mr. Stanley, we must conclude our notice of his book. We hope the publication of the new edition may lead to a more extended employment at least of these, and that the favour now shown throughout India and the Colonies, as well as England, for the instruments manufactured by the author's firm may be sufficient inducement to keep them up to their present high standard.

NOTES

THE announcement that Dr. W. B. Carpenter is about to retire from the post of Registrar of the University of London will be received with general regret. He has filled the office for twenty-three years.

PROF. MAREY has been elected to fill the place of the late Claude Bernard in the Section of Medicine in the Paris Academy of Sciences.

THE tenth annual report of the U.S. Geological and Geographical Survey of the Territories, in charge of Prof. Hayden, will be ready for distribution in a few weeks. The report has been in type nearly a year, but has been delayed on account of the engraving of the plates. These are now completed and the report will be issued at once. It contains 546 closely printed pages octavo, with eighty plates, sections, maps, &c. Fifty of the plates illustrate the remarkable cliff dwellers in Southern Colorado and Northern New Mexico. This is the last annual report pertaining to Colorado and contains a very interesting series of chapters on the geology of that remarkable country. On the whole this report will prove one of great popular interest and ought to have been published in great numbers. Only 4,500 copies have as yet been ordered. About 250 pages of the eleventh annual report of the field work for 1877 are in type at the Public Printing Office. This will contain a detailed description of the geological and geographical features of Southern Wyoming and Idaho. The reports of Sir Joseph D. Hooker and Dr. Asa Gray will give this volume a high character as well as great popular interest. 10,000 copies have been ordered by Congress. There will be very extended geological reports by Messrs. Endlich, White, St. John, and Peale, and geographical reports by Messrs. Gannett and Wilson, and special reports by Leidy, &c., &c.

VARIOUS items on electric lighting are to hand. It is telegraphed from Washington, December 7, that Mr. Edison's application for a patent for his electric light has been favourably passed by the Patent Office, and that the letters patent were to be issued on Tuesday. The *Journal* of the Society of Arts for December 6 contains a useful *résumé* of the practical application of electricity to lighting purposes, by Mr. J. N. Shoolbred. A new system of electric lamp has been invented in Paris and will be experimented on shortly in public. The carbon rods are four in number, as in the Rapieff system, but instead of crossing at an angle they are arranged in two parallel lines. The consumption of carbon for electric lighting is increasing so rapidly that M. Carré, the well-known Paris maker, is extending his works. He is manufacturing now at the rate of 2,000 meters a day. The electric light illumination has been prolonged, by a vote of the Municipal Council of Paris, up to January 19, for the Avenue de l'Opéra and the front of the Legislative Palace. The city engineers have received orders to prepare, during the interval, a report on the several systems which are now in operation or may be proposed.

THE New York papers report that Mr. Edison has stated that he has made an improved receiver for his telephone by means of which persons standing 15 feet from the instrument can hear a whisper uttered miles away.

AFTER the masterly works of Tschudi on "Animal Life in the Alps," and of Heer on the "History of Vegetation in Switzerland," another work likely to be of high value is announced,—H. Christ on the plants of that country—"Das Pflanzenleben in der Schweiz." The interest of the work is all the greater that Switzerland contains on its narrow area nearly all the diversity of plants which grow in middle and northern Europe. Many years' research of the author in the field, his previous works on separate parts of the Alps, as well as his connection with the botanists of Europe, have enabled Dr. Christ to publish a work which may be expected to range with those above-mentioned. It will appear in four fascicules, with many illustrations, and four maps of vegetable zones, one of which, the distribution of grapes and of several plants of the Föhn and lake regions, will appear this month. The whole work will be finished about the spring of 1879, the first half fascicule having just appeared.

A NEW Botanical Society has just been formed at Munich. the president is Prof. Robert Hartig, and the vice-president Dr. Arnold, an eminent lichenologist.

HERR ALBERT KÜPPERS, an eminent sculptor at Bonn, has

[1] It is here assumed for simplicity sake that the points at which the motion of the roller is reversed are at the extreme right and left of the figure.

just finished the model of a statue to be erected in memory of Prof. Jacob Nöggerath, the well-known mineralogist.

THE Chinese are about to commence the erection of a line of telegraph from Tientsin to Taku at the mouth of the Pei-ho, and also to make the necessary surveys for another line between Tientsin, Paoting-fu, and Peking.

ACCORDING to the *Colonies and India*, the surveyor, in making a survey of the new road at Mohikinui, in Buller County, New Zealand, struck a coal-seam five feet thick at a distance of only two miles from the township. The coal is bituminous and excellent in quality; it is, moreover, easily accessible and can be brought to the port at a very small cost.

THE Council of the Society of Arts have addressed a memorial to Lord Salisbury asking him to request her Majesty's Ministers abroad to collect information on the system of technical and industrial education in foreign countries, in continuation of what was published in 1868. Lord Salisbury has promised to give the matter his consideration, though we think this is rather an unfortunate time to address the Foreign Secretary on so peaceful a subject.

IN reference to the statement that Sir William Armstrong has employed electricity, generated by water power, a mile and a half distant, to light his picture gallery, and that he proposes to use the same force to turn machinery about his house, Mr. D. R. Jones sends us a copy of a letter sent by him to the *Australasian*, October 25, 1870, in which, referring to the phenomena of dynamic electricity, he states that it is evident that motion may be transformed into electricity, and *vice versâ*. He suggests that we may have here "the means of utilising the motions of the air and of water, which, for want of means of transmission, have been hitherto allowed to run to waste. Various methods of converting, transmitting, and utilising force will readily suggest themselves as a combination of these well-known facts. While we have such superabundant constant supplies of force it is not right that the stores of Nature should be ransacked."

THE *Times* of Monday contains another letter from Dr. Schliemann, giving an account of his further excavations on the site of Troy. He has succeeded in exploring much of the remains of the ancient structures so that the plan can be very distinctly traced. Dr. Schliemann himself left London on Monday for Paris, and intends to recommence work on March 1. A number of the objects found during the last explorations have been deposited in the South Kensington Museum, where they will be exhibited.

THE *Midland Naturalist*, we are glad to see, has concluded a successful first volume. Its past twelve numbers contain many papers of value, both on local and general scientific matters, and its conduct is creditable to its editors and to the many societies of which it is the organ. The December number contains a carefully compiled index, which must be a great comfort to those in search of any paper or subject in the volume. Several good contributions are promised for the next volume, and we trust that the journal will receive every encouragement from the members of the societies it represents, and that its conductors will strive to make it thoroughly representative of the science of the Midlands.

A CORRESPONDENT "R. C. J.," writes as follows from Driefontein, Heilbronn District, Orange Free State, South Africa, under date October 14:—"Our last winter was dry throughout, and unusually cold, that is, June, July, and August, and on August 3 a piece of country in the Transvaal, about seventy or eighty miles north of this part, and on the road from this to Pretoria, about fifteen or twenty miles wide, and perhaps the same in length, was visited in twenty-four hours with such a sudden change of temperature, from 85° to 42° F., that more than 100 bodies of dead Kafirs, besides oxen, were found as if killed by the sudden abstraction of caloric. There was no wind or rain, but a fall of snow. The land is about as high as this, about 4,600 feet."

EXCAVATIONS are now in progress on the Limburg, in the Bavarian palatinate, which will lead to important results for prehistoric investigation, inasmuch as they are directed to the elucidation of the much contested question regarding the constructors and former inhabitants of the Ringwall near Dürkheim.

La Semaine Française is the title of a new weekly French paper published in London for English readers, and which is meant to appeal "to all those who wish to read good French in the way in which it is most likely to be read with interest and profit." The number before us is well selected as to contents, and contains news of French matters and expressions of French opinion in various departments. A small amount of space, we are pleased to see, is devoted to science.

DR. RAE writes that at about 14m. past midnight of December 5-6, whilst there was bright moonlight, he observed a meteor of intensely bright and white light passing obliquely downwards from west to east. It was first noticed almost directly below the western foot of Orion, and disappeared when slightly to eastward of Sirius, having passed at 3° or 4° of arc below these stars. It was spherical and apparently of 6′ or 8′ diameter, with a fiery red tail four or five times that length.

AN earthquake occurred in Scotland on Tuesday morning last week at Balnacara and other parts of the district of Loch Alsh, on the west coast of the county of Ross, opposite the Isle of Skye. The shock was very marked, the tremulous motion of the earth being distinctly felt, and the houses shaking violently At Balnacara the shock occurred at 5 o'clock, and at Plocton, five miles distant, between 7 and 8.

AN Indian paper states that in the Ferozepore district the rise of the Sutlej has once more broken the head-works of the inundation canals, and over 100 square miles of country are under water. The damage done to property has been great, but on the other hand a quantity of treasure has been uncovered by the floods in the old fort of Momdote, a few miles from Ferozepore.

MR. CORNELIUS WALFORD has reprinted in a separate form his elaborate and valuable paper on "The Famines of the World, Past and Present," read in March last before the Statistical Society.

THE Eleventh Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology to the President and Fellows of Harvard College is an unusually interesting one. The description of the new museum buildings at Cambridge is very full, and illustrated with plans and a photographic view; the building seems admirably adapted to the purpose for which it is intended. Besides an account of the additions to the Museum and the work done since the last Report, the present publication contains the following papers:—"Second Report on the Implements found in the Glacial Drift of New Jersey," by Dr. C. C. Abbot; "The Method of Manufacture of several Articles by the former Indians of South Carolina," by Mr. Paul Schumacher; "Cave Dwellings in Utah," by Mr. Edward Palmer; "Notes on a Collection from an Ancient Cemetery in Southern Peru," by Mr. J. H. Blake; "Archæological Explorations in Tennessee," by Mr. F. W. Putnam (this long and amply illustrated paper is separately reprinted); "Observations on the Crania from the Stone Graves in Tennessee," by Mr. Lucien Carr; "On the Tenure of Land Among the Ancient Mexicans," by Mr. A. F. Bandelier. Besides Mr. Putnam's paper most of the others are accompanied by numerous illustrations.

In a note on "Colonial Grasses as Paper-making Materials," the *Colonies and India* suggests the possibility of utilising some of the coarse grasses which grow with such provoking pertinacity in South Africa, Australia, New Zealand, &c. The *Typha angustifolia*, for example, a large kind of tussock grass (known as *raupo* to the New Zealand natives, who use it for thatching their houses), which grows in enormous quantities in the swampy flats near rivers and lakes, may, like its neighbour, the *Phormium tenax*, prove a rival to Esparto grass; the *wiwi*, a coarse, wiry kind of grass, growing chiefly in the interior of North Island, is also worth an experiment. In New South Wales the grass-cloth plant (*Böhmeria nivea*) has already received some attention, being used for the manufacture of a fine kind of matting. South Africa is probably richest of all in its grasses; in the great Karroo district thousands of square miles are covered with the twaa-grass, the sour-veldt, and the sweet-veldt, the importance of which as fodder may be found equalled by their value as paper-making material. Still more likely to prove valuable is the *Stipa capensis*, a member of the family to which Esparto belongs.

The *Transactions* of the Cumberland Association for the Advancement of Literature and Science, Part III., 1877-78, edited by Mr. Clifton Ward, is a thickish volume containing papers by members of some of the Associated Societies. The first paper, however, after various reports, is that by Sir George Airy, on the "Probable Condition of the Interior of the Earth," a report of which we gave at the time of its delivery; accompanying it is a diagram of an ideal earth. Mr. Ward has a paper on "Quartz in the Lake District;" Mr. C. Smith one on "Boulder Clay;" Mr. Pickering, on a "Submerged Forest at St. Bees;" and Mr. Fisher Crosthwaite gives an interesting account of Peter Crosthwaite, who, at the end of the last and beginning of the present centuries, did much to promote science in the district.

M. J. Poliakoff, who was sent last summer by the St. Petersburg Academy of Sciences to examine the remains of the stone period in the governments of Yaroslaff and Vladimir, gives the following results of his explorations:—Very interesting collections were found in excavating a mound, close by Yaroslaff; numerous skulls of men of the neolithic period were discovered here, together with polished silex hatchets and hammers, and numerous bones of animals of existing species. Far richer collections were found in the valley of the Oka River, in the district of Murom. Here, in the sandy mounds of the valley, as well as in the alluvium of the river, M. Poliakoff has discovered immense quantities of silex implements, polished and rough, of the most varied forms. The implements were always found together with bones of the *Castor fiber*, the *Sus scrofa ferus*, and the *Bos primigenius*, none of which exist now in those regions. Besides, he also discovered vestiges of old wood buildings, very like the lacustrian dwellings of Switzerland. The most important discovery during these explorations was made by M. Poliakoff, in company with Count Uraroff, close by Karacharovo Town, in a very old lake alluvium, being a somewhat washed-up glacier deposit. Here they found rough stone implements of the paleolithic period, together with bones of the mammoth, rhinoceros, and the *Bos priscus*. The character of the deposits proved without doubt the co-existence of man with those extinct mammals in Russia, as well as in other parts of Europe. After having finished his explorations, M. Poliakoff made a journey in Western Europe to study the chief museums, and to compare the implements he has collected during many years in Russia and Siberia, Western and Eastern, with those of England, Sweden, Denmark, France, and Switzerland. We expect that this last journey of M. Poliakoff will accelerate the opening of the projected pre-historic museum at St. Petersburg.

The additions to the Zoological Society's Gardens during the past week include two Black-faced Spider Monkeys (*Ateles ater*), two Rufous-vented Guans (*Penelope cristata*) from U. S. of Columbia, two Horsfield's Tortoises (*Testudo horsfieldi*) from Turkestan, presented by Mr. A. Gonzalez Carazo; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. A. G. Lytton Squires; two Black-eared Marmosets (*Hapale penicillata*) from South-East Brazil, presented by the Countess of Cotterham; two Laughing Kingfishers (*Dacelo gigantea*) from Australia, presented by Mr. Edwin A. B. Crockett; a Ceylon Jungle Fowl (*Gallus stanleyi*) from Ceylon, two Japanese Pheasants (*Phasianus versicolor*) from Japan, a Grey Francolin (*Francolinus ponticerianus*) from India, presented by Mr. Geo. Lyon Bennett; a Rhomb-marked Snake (*Psammophylax rhombeatus*), three Rufescent Snakes (*Leptodira rufescens*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Kinkajou (*Cercoleptes caudivolvulus*) from South America, three Snow Buntings (*Plectrophanes nivalis*), European, purchased.

ROYAL SOCIETY—THE PRESIDENT'S ANNIVERSARY ADDRESS[1]

II.

The modern development of botanical science, being that which occupies my own attention, is naturally that on which I might feel especially inclined to dwell; and I should so far have the excuse that there is, perhaps, no branch of research with the early progress of which this Society is more intimately connected.

One of our earliest secretaries, Robert Hooke, two centuries ago, laboured long and successfully in the improvement of the microscope as an implement of investigation. He was one of the first to reap the harvest of discovery in the new fields of knowledge to which it was the key, and if the results which he attained have rather the aimless air of spoils gathered hither and thither in a treasury, the very fulness of which was embarrassing, we must remember that we date the starting-point of modern histology from the account given by Hooke in his "Micrographia" (1667) of the structure of cork, which had attracted his interest from the singularity of its physical properties. Hooke demonstrated its *cellular structure*, and by an interesting coincidence he was one of the first to investigate, at the request, indeed, of the founder of the Society, Charles II., the movement of the sensitive plant *Mimosa pudica*, one of a class of phenomena which is still occupying the attention of more than one of our Fellows. In attributing the loss of turgescence, which is the cause of the collapse of the petiole and subordinate portions of the compound leaf which it supports, to the escape of a subtle humour, he to some extent foreshadowed the modern view which attributes the collapse of the cells to the escape of water by some mechanism far from clearly understood—whether from the cell-cavities or from the cell-walls into the intercellular spaces.

Hooke having shown the way, Nehemiah Grew, who was also secretary of the Royal Society, and Marcello Malpighi, Professor of Medicine in the University of Bologna, were not slow to follow it. Almost simultaneously (1671–3) the researches of these two indefatigable students were presented to the Royal Society, and the publication of two editions of Malpighi's works in London prove how entirely this country was at that time regarded as the head-quarters of this branch of scientific inquiry. We owe to them the generalisation of the cellular structure, which Hooke had ascertained in cork, for all other vegetable tissues. They described also accurately a host of microscopic structures then made known for the first time. Thus, to give one example, Grew figured and described in several different plants the stomata of the epidermis:—"Passports either for the better avolation of superfluous sap, or the admission of air."

With the exception of Leeuwenhoek no observer attempted to make any substantial addition to the labours of Grew and Malpighi for more than a century and a half, and however remarkable is the impulse which he gave to morphological studies, the view of Caspar Wolff in the middle of the eighteenth cen-

[1] Address of Sir Joseph Hooker, C.B., K.C.S.I., the President, delivered at the Anniversary Meeting of the Royal Society, on Saturday, November 30, 1878. Continued from p. 113.